Odessa centre | Pastoralism Research, Policy and Practice

TYPE Special Issue Editorial
PUBLISHED 12 June 2026
DOI 10.3389/past.2026.16611

Check for updates

OPEN ACCESS

EDITED BY
Margaret Ndapewa Angula,
University of Namibia, Namibia

*CORRESPONDENCE
Andrei Marin,
andrei.marin@nmbu.no

RECEIVED 19 March 2026
REVISED 27 April 2026
ACCEPTED 29 May 2026
PUBLISHED 12 June 2026

CITATION
Marin A, Davies J, Flintan F, Kerven C and Singh R (2026) Editorial: The role of pastoral livestock and products in climate change: a complicated issue. *Pastoralism* 16:16611.
doi: 10.3389/past.2026.16611

COPYRIGHT
© 2026 Marin, Davies, Flintan, Kerven and Singh. This is an open-access article distributed under the terms of the Creative Commons Attribution License (CC BY). The use, distribution or reproduction in other forums is permitted, provided the original author(s) and the copyright owner(s) are credited and that the original publication in this journal is cited, in accordance with accepted academic practice. No use, distribution or reproduction is permitted which does not comply with these terms.

Editorial: The role of pastoral livestock and products in climate change: a complicated issue

Andrei Marin[1]*, Jonathan Davies[2], Fiona Flintan[3], Carol Kerven[4] and Rashmi Singh[5]

[1]Department of International Environment and Development Studies, Norwegian University of Life Sciences, Aas, Norway, [2]International Consultant, Independent, London, United Kingdom, [3]International Livestock Research Institute Ethiopia, Addis Ababa, Ethiopia, [4]Odessa Centre, Carterton, United Kingdom, [5]Indian Institute of Technology Hyderabad, Hyderabad, India

KEYWORDS
climate change, development, emission intensity, pastoralism, tier 2

Editorial on the Special Issue
The role of pastoral livestock and products in climate change: a complicated issue

Introduction

There are a lot of livestock in the world. Different species and breeds are raised in many types of places and climates. First domesticated more than 10 thousand years ago, livestock have provided people with food, transport, clothing, artefacts and income through exchange. Certain livestock are deified and imbued with deep cultural values. Many people depend directly or indirectly on livestock, and enjoy consuming their products. Livestock transform landscapes and the ecology through their need for forage, feed and water, and just by walking. Current environmental narratives often portray livestock as a contributor to biodiversity loss and global warming, yet counter narratives highlight the role pastoral livestock systems have played in creating habitat, protecting bioidiversity and protecting carbon stocks. The studies in this Special Issue delve into questions about which kinds of impacts livestock are having on climate change, by evaluating why, how and where these impacts occur. A key variable is the degree to which livestock are managed intensively or extensively. There are context-specific positive and negative relationships to climate change depending on these management divergences. The goal is to seek which might be the best options for lowering livestock's negative impacts on the climate and promoting positive impacts.

Raising livestock and consuming their products is increasingly being scrutinized for its role in greenhouse gas emissions and, hence, climate change. Since the landmark publication of "Livestock's Long Shadow" nearly 20 years ago (Steinfeld et al., 2006) by the Food and Agriculture Organization of the United Nations (FAO), the attention of researchers, policymakers, the media and the public has been drawn to questions about the environmental consequences of rearing domesticated animals. Data, research and opinions are proliferating, and yet scientists, practitioners and advocates seem to reach differing conclusions both about the problem and its solutions.

In part, this is not surprising. FAO data for land use show that one-fourth (almost 3.2 billion ha) of the world's land area is covered by permanent meadows and pastures[1] (FAO, 2022) and that ca. 80% of all agricultural land is used for livestock as either grazing land or fodder production (FAO, 2009). Amongst the people involved in rearing some of the estimated 4.6 billion livestock (excluding poultry and pigs) (FAOStat, 2026) on all continents are several hundred million pastoral people with a variety of production systems, climates, livestock species and environments. There are evidently difficulties in discussing monolithic impacts of pastoralism on climate change. Still, academic debates and policy making often draw on uniform approaches that rely on an approximation of each livestock species' impact based on the standardized data used by the Intergovernmental Panel on Climate Change (IPCC). This can lead to misrepresentations of the complex realities of such systems.

A recent exchange between the United Nations Framework Convention on Climate Change (UNFCCC) and the Norwegian statistics authority has revealed that the reported enteric methane emissions from sheep in Norway have been overestimated by 30% in every yearly report, going back to 1990 (Aase, 2025). Similarly, a global meta-analysis of methane emissions from bovids indicates that the emissions from all yaks on the Asian Plateau may be as much as 39% lower than the standard IPCC model (Tier 2[2]) would estimate (Shi et al., 2025). This is not to say that the IPCC models and standard coefficients are wrong, or always overestimate. Despite their flexibility[3], such estimates still need to rely on difficult decisions surrounding simplifications and approximations of each livestock system.

Hayek and Miller (2021) point out that the details needed for developing reliable methane emission indicators are incredibly fine-grained and would need information on for instance how much an animal moves during a day, the seasonal cycle of weather conditions, the temperature of the animal operation facility and even whether or not a crust is allowed to develop on top of the liquid manure tanks. Because of this, measuring emissions in the atmosphere above the livestock system seems to hold potential for better estimates, and at least one study (ibid) shows that for highly intensive systems, methane emissions may actually be as much as 90% higher than IPCC calculations would suggest. Importantly, this discrepancy also indicates that we need to be cautious of the hypothesis that intensifying livestock systems would in fact lead to a reduction of greenhouse gases emissions, especially in developing countries (ibid) and that even with ambitious and costly technological improvements, the effect may be as little as less than a quarter of the emissions in the business-as-usual scenario (Höglund-Isaksson et al., 2020, cited in Hayek and Miller, 2021). And this is before we even start discussing any other social and environmental costs and benefits connected to such uncertain transformations.

Another important concern is around the data bias; as noted by Scoones (2023), most of the data used in the greenhouse emission assessments is gleaned from intensive livestock systems from the global North, while the narratives about GHG emissions from livestock continue to influence policies towards the extensive systems of pastoralists of the global South.

There are high stakes in understanding emissions, and more generally the relationship between livestock production and climate change, since positions taken by governments, international donor organizations and NGOs on these questions can influence support for the livestock sectors, e.g., through the Breakthrough Agenda (Mukherji et al., 2024). Consumers are also increasingly interested in where their food comes from and its impact on the environment, and they make choices about which foods to buy or avoid. Official dietary guidelines, although very different across continents, are in some cases promoting a major reduction in livestock products—especially meat—for "planetary health" (EAT, 2025), and at the same time draw criticism, more recently manifested as legislative initiatives banning the use of meat-related product names such as "hamburgers" and "sausages" for plant-based alternatives (BBC, 2025).The textile industries are also responding with alternatives to livestock products, marketed as less climate damaging. Consumer and policy choices thus reflect the interest in the topic and are likely to have consequences for livestock owners and sustainable rangeland management the world over. The choices are nevertheless based on a limited understanding of the complex relation between pastoralist systems and climate change, one that seldom accounts for local specificieties and indirect effects of pastoralism on climate, through mechanisms such as carbon sequestration (Ali et al., 2016; Assouma et al., 2019), biodiversity preservation (Briske et al., 2026) and albedo maintenance (Beer et al., 2020; Kristensen et al., 2024).

What this Special Issue shows

This Special Issue aims to probe the debate by exploring the roles livestock play in climate change, but especially differentiated according to two distinct types of livestock production system–intensive and extensive. While there are numerous forms of livestock production, varying by environment, animal species, social relations, management methods and world regions, these can be generically grouped into these two forms. The first form is intensive, characterised by greater reliance upon capital investment, technologies such as housing and fencing, and supplementary feed, which allows a denser population of animals per area and a faster animal growth resulting from high inputs such as concentrated feed and antibiotics. The second form is extensive (termed pastoralism), in which animals are predominantly grazed on open pastures, often with mobile herding and communal land use, and characterised by lower external inputs, a higher ratio of

1 In Europe 1/3 of agricultural land, in Latin America, Africa and Asia 3/4 (FAO, 2022).

2 A tier represents a level of methodological complexity for estimating greenhouse gas emissions. Tier 1 is the basic method and relies on global default values, Tier 2 is intermediate and relies on localized emission factors at national or regional level, while Tier 3 is the most complexand detailed, relying on modelling and facility-level measurement. Tiers 2 and 3 are sometimes referred to as higher tier methods and are generally considered to be more accurate (IPCC, 2019).

3 The estimates rely to a large extent on the parameter Y_m which measures how much of the feed energy is converted to methane and is estimated to vary greatly with several feed and animal factors, for instance between 1% and 6.5% for grazing cattle and mature sheep (IPCC, 2006, 10.30).

labour and a lower livestock population per land area, compared to intensive management.

The types of inputs and outputs of these two broadly dissimilar systems are well-studied by now. There are estimates of the impacts of each system on climate change. Evidence is accumulating that intensive livestock systems can have greater negative impacts than extensive systems for climate change, while extensive systems can play a substantial role in safeguarding climate regulating (and other) ecosystem services. To assume that all livestock production systems have comparable harmful environmental effects on the climate may overlook the beneficial effects of extensive systems like pastoralism.

However, the evidence also indicates opportunities to improve production efficiencies in the pastoral livestock sector. Corrêa et al., this Issue find that a degree of intensification of extensive livestock production can generate greater food output per unit of energy consumed and GHG emitted, but some of these efficiencies may be lost when livestock systems transform to being fully intensive. This reflects both a loss of some of the environmental benefits of extensive grazing systems, and a tipping point beyond which intensification leads to energy-hungry, mechanised and presumably lower labour-intense production.

The Special Issue seeks to disentangle the relations between livestock and climate change by examining the evidence. True to the ethos of *Pastoralism-research, policy and practice,* we have encouraged contributions from academics and practitioners, with the assumption that good ideas and insights often emerge at the interface between the generalizable and the particular, lived experiences.

The contributions have both confirmed existing knowledge and surprised us, the editors. On the one hand, this collection shows in detail and with empirical evidence what has emerged as a counter-narrative to the wholesale demonization of livestock keeping: *"it's not the cow, is the how!"*. In other words, if we look at the impact of livestock keeping in any other way than the most reductionist counting of GHG molecules, there are huge differences between systems, livestock species and age groups, etc. The following synopses of 7 country case studies from Brazil, India, Kenya, Mongolia (2), Tanzania and Turkey, as well as 4 general reviews, demonstrate this variability.

Mwilawa et al., this Issue compare traditional pastoral systems (grazing) with feedlot systems in Tanzania, showing how supplementary feeding of concentrate improves cattle performance, thus raising the feed conversion ratio and lowering the emission intensity of methane, meaning less methane is produced per unit of product due to weight gain. The study also noted breed Special Issue, with Boran cattle producing more enteric methane than Tanzanian Short Horn Zebu, likely due to differences in dry matter intake associated with their body size. Despite being younger, Boran cattle's higher frame size correlated with greater feed intake, and therefore higher emissions. However, the article also recognises that such comparisons do not take into account other environmental benefits of more extensive livestock systems, including how pastoral systems can also significantly contribute to the provision of ecosystem services, which can increase with good management.

The article by Franca et al., this Issue goes further and points out the limitations in approaches that look at the impact of livestock systems on climate change in isolation from all the other interactions within pastoralist systems. Based on a large 6-year comparative investigation of pastoral systems across Africa, Asia and Europe, they conclude that even the more detailed Life Cycle Assessment (LCA) approach falls short of accounting for the real, complex interactions between livestock systems and the environment. To begin with, emissions need to be accounted for in a broader ecosystem context; secondly, the impact must also account for the carbon sequestration that these systems facilitate and their impacts on biodiversity. Importantly, they point out, pastoral systems and their impact on the environment (including climate change) can only be understood if we take into account other elements that characterize these systems: land occupancy, patterns of resource use, but, equally important, also their contribution to social and nutritional aspects.

The paper on impacts of cattle farming practices on energy balances and greenhouse gas emissions in different livestock systems of Amazonia, Brazil (Corrêa et al., this Issue), examines greenhouse gas emissions and energy use in relation to the sustainable development of livestock systems. These livestock systems can be characterized as livestock grazing ranches of varying sizes. The region supports a diversity of livestock systems, including dairy and beef fattening units with different degrees of intensification and social and economic inclusion.

In terms of energy efficiency among the Amazonian cattle farms, moderately intensified farms have similar energy consumption per hectare to extensive farms but achieve 55% higher meat production. Intensive farms achieve dramatically higher yields per hectare (9 times higher than in extensive systems), but energy consumption per hectare is 14 times higher, primarily due to increased use of fertilization and supplemental feed. Extensive and moderately intensified farms have similar GHG emissions per hectare, while intensive farms emit 7 times more GHG per hectare than extensive farms, with methane accounting for the bulk of emissions. However, intensive farms have 55% lower emissions per ton of meat than extensive farms (Corrêa et al., this Issue).

The paper underscores that eco-efficiency can be increased through moderate intensification, but the efficiency gains may be reversed through further intensification. This finding may be relevant in other contexts and to understanding the need for distinct development goals, policies and trajectories between intensive and extensive livestock systems.Recommended practices – many already used by pastoralists - that can capture eco-efficiencies include rotational grazing, improved management of stocking rates, maintaining soil fertility, restoration of pastures, and forage management.

The case study in Kenya by Gurmu et al., this Issue highlights the challenges of measuring methane emissions from pastoral systems. Using animal activity data across different seasons (reflecting usual system climate variability), mean Tier 2 annual emission factors were calculated for different cattle age categories. The results revealed significant differences across the locations based on breeds, herd composition, live weight, weight gains, milk yield and digestible energy, all of which influenced methane emissions. The findings stress how using Tier 1 assumptions on pasture-based cattle emissions that do not account for such variability risks miscalculating pastoral systems' emissions.

Similarly, the contribution by Lkhamaachin et al., this Issue also shows the need for more precision in analysing emissions across the very extensive pastoralist systems of Mongolia. In an effort to produce relevant country-specific Tier 2[4] calculations of methane emissions from sheep, they compare emissions differentiated by the sex and age of sheep and by season across three agro-ecological zones (desert-steppe, steppe, and forest-steppe). Unlike standard estimates based on the IPCC universal indices mentioned above, this research relies on measurements of sheep's seasonal weight change, pasture quality and energy expenditure with migration, an essential activity for pastoralist systems which is often not calculated in standard analyses (Lkhamaachin et al., this Issue).

Some of their findings are predictable (females have consistently higher emissions than males, and older have higher emissions than the young), but there are also interesting surprises. Young adult sheep (1–2 years old) emitted up to 20% less than adult sheep and lower than the standard IPCC value, while for mature sheep (older than 3 years) and lambs (younger than 1 year) these values exceeded the IPCC standard. Moreover, Mongolian sheep seem to use more of the energy intake to transform into methane energy, presumably due to the combined effects of harsh climatic conditions, extensive mobility, and the relatively low digestibility of the steppe forage. One of the take-home messages from this contribution is that the application of standard default values for GHG emissions may be misleading due to the influence of forage quality, seasonal energy dynamics and physiological status of the animals. For the Mongolian system, the authors propose, this acknowledgement would mean that instead of standard solutions like reducing numbers of livestock or intensification, one should implement management decisions targeted particularly to ewes during pregnancy and lactation (Lkhamaachin et al., this Issue).

The theme of how best to assess the impact and what management options are optimally suited is also picked up by the contribution from Franca et al., this Issue; they insist on the need to challenge the sometimes simplistic and misleading policy messages without falling into the temptation of advocacy. Instead, they propose a very insightful exploration of how Life Cycle Assessment (LCA) methodology of GHG emission can be extended to include patterns of spatial heterogeneity and temporal variability in emissions, as well as environmental impacts (e.g., carbon sequestration, biodiversity) and social (e.g., nutritional security, health) impacts. Such approaches would expand the LCA to better methodologies such as Environmental LCA, Life Cycle Costs or Social Life Cycle Assessment.

Such flexible and system-wide approaches would be better suited also when analysing the complexities illustrated by the article "Contributions of goats to climate change: how and where" (Kerven, this Issue). Although pastoralist systems depend on a variety of livestock species, goats typically received particularly 'bad press' in recent decades for their perceived environmental impact. This is why the review presented by this contribution is particularly timely and useful. It is timely in part because it underlines the importance goats have in many environmentally challenging and socially marginalized pastoralist systems across continents.

A compounding factor in the contribution of goats to climate change is, of course, the contribution of some breeds to the global market for cashmere fibre, associated with luxury garments. As the article clearly shows, though, one of the more important features of the goat-based pastoral systems is that they play an important role in building up livelihoods in very difficult socio-environmental contexts. Importantly, this overview shows that because goats have a high feed conversion efficiency, they emit less entheric methane than all other domestic ruminants, while these pastoralist systems raising goats are also just as varied. In consequence, any discussion of the role of goats in climate change needs to be based on specific evidence and with a broad field of vision that includes a variety of environmental and social impacts they may play (Kerven, this Issue).

Such a broad approach is taken by the article "Goat transhumance in Mediterranean Turkey: characterization and key factors driving its transformation" (Ocak Yetişgin and Canan, this Issue), which describes how transhumant goat production is influenced by policy frameworks, market integration, ecological shifts, and socio-political dynamics. The paper analyses the Sarıkeçililer community in southern Turkey, who annually migrate 400–450 km between coastal highlands and upland pastures, encompassing both Mediterranean and continental mountain climates. The long-distance transhumance is embedded in the community's culture and tradition, which continues to prioritize household-level subsistence and informal local exchange networks. This creates a partial detachment from structured markets, rendering pastoralism more vulnerable to marginalization. On the other hand, market engagement has influenced flock composition and grazing patterns, as many farmers have adopted higher-yielding breeds that are more dependent on intensive feeding and management.

Climate change is exerting a significant impact on pastoralists in Turkey, through reduction in the quality, quantity and timing of forage and through direct physiological impacts of increased temperatures (Ocak Yetişgin and Canan, this Issue). Climate disruptions have restricted access to pasture and compromised herd health, while increasing labour demands and management uncertainty. Looking ahead, the paper concludes that pastoralism needs to be recognised as a cornerstone of sustainable agriculture, not as a relic of the past. Transhumance can continue to operate as a model of environmental stewardship in the twenty-first century by embedding low-carbon practices, circular resource use, and adaptive governance into pastoral systems. This will require transhumant systems to be integrated into regional land-use planning for both social equity and environmental sustainability, and for pastoralists to be granted better access to veterinary, financial, and market services. The future of transhumance in Turkey is uncertain without deliberate institutional support.

Ngongolo and Gayo, this Issue review the evidence over the last two decades of climate change effects on small holder livestock-keepers in sub-Saharan Africa, including pastoralists, whose livestock production is relatively more vulnerable to climate changes of more erratic or extreme precipitation and temperatures which alter forage availability and livestock disease transmission. In considering efforts to mitigate the negative effects

4 The article uses a combination of global default values (Tier 1) and locally modelled and measured data (Tier 2) on live weight, energy expenditure and forage energy content.

of climate change on small holders' livestock production, the authors point out that studies often overlook the triple-bottom line of social, economic, and environmental aspects in mitigation efforts. While strategies combining carbon sequestration and reduction of GHG emissions offer optimal mitigation, attention should shift towards holistic, multi-faceted approaches which take into account the broader purposes of livestock systems, especially to small holders such as many pastoralists–such as nutrition, social capital, savings and investment. The paper concludes that promotion of agroforestry, rotational grazing (mobility) and soil conservation techniques can not only mitigate impacts of climate change on livestock production, but also reduce the impacts of livestock on greenhouse gases associated with climate change.

The study from the Indian Himalayan region of Jammu and Kashmir by Banka et al., this Issue argues that the traditional rotational grazing by the Chopan community in Trahan pasture remains well within ecological limits, helps to maintain soil fertility and contributes to regional food security, especially in the context of a decline in agricultural land and growing protein deficit. However, despite these benefits to rangelands, the community continue to face structural marginalization, which includes exclusion from land rights and policy frameworks.

Davies et al., this Issue examine the potential role of pastoral lands for opportunities and risks of green transition projects, such as renewable energy and carbon sequestration. The authors map the global photovoltaic and wind energy potential which shows the high potential that lies within the rangelands used by pastoralists. This finding explains the growing demand for pastoralists' land from carbon offsetting and renewable energy actors. The demand for pastoral land is forecast to grow due both to the rising demand for renewable energy and the widespread perception that pastoralist lands are underused and unclaimed. Such a persistent and erroneous rangeland narrative has caused land use change and land alienation on many occasions.

Davies et al., this Issue however provide examples of green transition projects in rangelands that demonstrate both harmful and beneficial outcomes for pastoralists. They argue that equitable green transition projects have been implemented in rangelands in a few countries (e.g., Kenya, Mongolia), based on securing local communities' consent and compensating them in various ways for the use of their land (in the case of renewable energy) or involving them meaningfully in rangeland rehabilitation (in the case of carbon offsets). These examples raise the possibility that green transition projects could make a significant contribution to pastoralist livelihoods, for example by helping secure pastoralist land rights and strengthen their livelihoods. However, to promote a just green transition, they argue, stronger safeguards are urgently needed, combined with raising awareness among investors of pastoralists' rights, and development of more significant benefits for pastoralists.

The paper by Imoli, this Issue, an ethnographic study conducted in Selenge province of northern Mongolia, provides several distinct and vital contributions to the SI. Imoli critiques the 'detached' and 'abstract' concept of climate change used by institutions, which fails to capture the local manifestations and the existential gravity of the crisis experienced by the pastoralists. Imoli argues that the climate crisis is not just an ecological phenomenon but is deeply entangled with the socio-political transformations of the post-socialist transition, including the retreat of the state, livestock privatization and the emergence of severe economic precarity.

Imoli points out the irony inherent in the current rangeland management models dealing with climate solutions, where the pastoralists participate in biodiversity compensation projects funded by mining companies – the same industries competing for their land and contributing to degradation. This process emphasizes how a pastoral system, which was previously integrated with the management of land, labour and livestock through both formal state and informal customary practice, after the collapse of socialism in the 1990s, got uprooted from its social and ecological foundations. This led to an institutional void that left the pastoralists to navigate a volatile free market and changing climate with bare minimum institutional support. The study reveals how climate interventions often fail because they are disconnected from the pastoral institutions and social networks that effectively work alongside the formal state to maintain the rangeland ecosystem integrity (Imoli, this Issue).

Several of the authors of this Special Issue recommend policy reform. In particular, they advocate for policies developed through community participation and respect for culturally embedded knowledge systems, with context-specific economic and climate support mechanisms which recognize pastoralism as a viable model for environmental resilience and adaptability. In the absence of such support, centuries-old pastoral systems will continue to decline, resulting in irreversible losses to both cultural heritage and ecological integrity (Ocak Yetişgin and Canan; Banka et al.). As highlighted by Imoli, this Issue the global efforts to tackle climate change and conservation issues (which are equally embedded in pastoral systems) must move beyond the technocratic model to account for the complex social networks and felt sense of political abandonment that define the realities of contemporary pastoral lives.

What is left unanswered, and the way forward

Our initial intention with the SI was to, at a minimum, open some knowledge areas for debate. We sought to expand the concentration of research beyond the usual confines of adaptation to climate change by shifting the question to what is the active role of pastoralism in climate change— both positive or negative. Our 'working hypothesis' has been that a nuanced context-specific understanding of pastoralist systems may open up new ways to reduce or mitigate the negative impacts where possible. Pastoralism and pastoralists could play a future role in climate change mitigation. This is a relatively less developed field of research.

Pastoralism and its impact on the environment have always been a contested field of study. This goes back to ideas about Bedouin pastoralists' environmental damage in the 14th century (Duffy, 2019). Today, this debate is significantly geared towards GHG emissions, but as this collection aptly illustrates, the debate often relies too much on simplistic assumptions and estimates, and not enough on empirical data. The work of contextualizing, recalibrating and testing general ideas needs to continue. The goal, we propose, should not be to find common metrics, but

rather to understand complexities and particularities specific to individual pastoral systems. As this collection suggests, pastoralist systems and their impact on climate change can vary substantially. If policy frameworks are to ensure environmental sustainability, they need to be based on reliable accounts of emissions and on understanding the complex interactions that pastoral livestock systems have with their environments. The papers in the SI indicate that efforts are underway to understand these relationships better and that some equitable solutions for sustainable pastoralist development may be within reach.

The SI emphasizesthe need to differentiate between development pathways for extensive and intensive livestock systems rather than treating these as points along a development continuum (Mwilawa et al. this Issue). Referring to the development of extensive systems as a process of 'intensification' can be misleading, and the development objectives of extensive systems need more clarity. This includes clarifying the full range of outputs from extensive systems, such as the contribution to biodiversity conservation and climate change mitigation, and how these values may be traded off against increased livestock yields. As also concluded in the study by Banka et al., this Issue "applying these metrics to extensive pastoral systems, which are context-specific and low-input, often leads to a mischaracterization of their environmental impact".

The article by Corrêa et al., this Issue on Brazilian livestock systems shows that low efficiencies in extensive systems are attributed to the use of dual-purpose breeds that have low milk yields, although the paper is unclear on the eco-efficiency of combining meat and dairy production on the same land area. Improvements in livestock production efficiency that are compatible with extensive production systems can provide economic benefits to producers as well as climate benefits. Further research into the combined values and efficiencies of producing multiple products would be of greater value to pastoralist systems in other parts of the world. This type of research would benefit from considering the biodiversity impacts of different farming systems, including the value of grassland biodiversity and the risks resulting from grassland intensification through monocultures and soil amendments. The impact of grazing practices on biodiversity and ecosystem functions may have both intrinsic and instrumental values that deserve closer examination in future studies.

The solution proposed by Franca et al., this Issue is also worth reiterating: rather than looking at critiques of standard emission measurements as revamped 'advocacy work', there is much to be gained by looking at alternative, improved methods for measuring the impacts of livestock systems on climate. Therefore, future studies can gain both precision and relevance if their calculations incorporate more fine-grained measurements that rely on local seasonal data and that include additional metrics, such as Environmental LCA, Life Cycle Costs or Social Life Cycle Assessment. As illustrated by several contributions to this SI, this work has already begun. Combatting the climate crisis is not just about the data metrics and reducing livestock numbers, but unpacking the management systems across geographic scales, and also about protecting the mobility and land rights of those who maintain the rangelands. However, the next steps would be to recognize that pastoralists and scientists inhabit different but equally vivid worlds, and policies must bridge these world views to be fair and effective.

Notwithstanding common misconceptions, pastoralist systems are neither isolated from the larger society nor uniform, and are both affected by and contributing to climate change and its mitigation in various ways. Portrayed as a potential solution to combatting climate change - the green transition is not a parallel project to sustainable development, but is a catchphrase that is intended to encompass development practices as a whole. Rather than debate whether or not pastoralism can benefit from the green transition, pastoralists may be better served by recognising that a green transition is underway and that a just, equitable, transition could contribute to many pastoralist development goals. To do so, however, the transition must be pursued based on a full understanding of the value of rangelands and their ecosystem services, and of how investments (such as in renewable energy projects) can contribute to securing pastoralist land and enabling their land management. Recognising the complexity of pastoral land use on the ground can help foster complementarity between energy generation and livestock production on rangelands.

The International Year for Rangelands and Pastoralism (IYRP) in 2026 can be an opportune turning point in achieving more detailed attention, renewed research interest and policy dialogue on the role of pastoralism in climate change. This global initiative, which unites more than 420 organizations, aims to dispel myths about pastoralism, strengthen global policy frameworks, and ensure that rangelands and pastoralists are fully integral to sustainable development (Niamir-Fuller, 2026). This means recognising the complexity and diversity of pastoralist systems' contribution to climate change, as illustrated in this collection. Nuanced understanding is indispensable to advancing just policy pathways for rangelands and distinctive livestock production systems.

Author contributions

AM, CK and JD designed the manuscript, all authors contributed to writing, summarizing individual contributions and editing drafts. All authors contributed to the article and approved the submitted version.

Conflict of interest

The authors(s) declared that this work was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Generative AI statement

The author(s) declared that generative AI was not used in the creation of this manuscript.

Any alternative text (alt text) provided alongside figures in this article has been generated by Frontiers with the support of artificial intelligence and reasonable efforts have been made to ensure accuracy, including review by the authors wherever possible. If you identify any issues, please contact us.

References

Aase, B. B. (2025). Norway has reported too high emissions from sheep: 30 per cent cut [in Norwegian]. *Nationen*, 2025.

Ali, S., Kuhn, M. J., and Fikre, T. Z. (2016). The role of pastoralism in regulating ecosystem services. *Revue Sci. Tech. de l'OIE* 35 (2), 435–444. doi:10.20506/rst.35.2.2534

Assouma, M. H., Lecomte, P., Corniaux, C., Hiernaux, P., Ickowicz, A., and Vayssières, J. (2019). Pastoral landscapes in the Sahel: a carbon balance with unexpected potential for climate change mitigation. *Perspect. Engl. Ed.* 52, 1–4. doi:10.19182/agritrop/00083

BBC (2025). *No More Veggie Burgers? EU Parliament Votes to Ban Meat Names for Plant-based Foods*. EU parliament votes ban meat names plant-based foods

Beer, C., Zimov, N., Olofsson, J., Porada, P., and Zimov, S. (2020). Protection of permafrost soils from thawing by increasing herbivore density. *Sci. Rep.* 10, 4170. doi:10.1038/s41598-020-60938-y

Briske, D. D., Cromsigt, P. G. M., Davies, J., Fernández-Giménez, M. E., Luizza, M. W., Manzano, P., et al. (2026). Pastoralism can mitigate biodiversity loss on global rangelands. *BioScience* 76 (1), 78–89. doi:10.1093/biosci/biaf158

Duffy, A. (2019). *Nomad's Land: Pastoralism and French Environmental Policy in the Nineteenth-Century Mediterranean World*. Lincoln: University of Nebraska Press.

EAT (2025). *The EAT-lancet commission on healthy, sustainable, and just food systems*. The EAT-lancet commission on healthy, sustainable, and just food systems

FAO (2009). *The state of food and agriculture. Livestock in the balance*. Rome. The state of food and agriculture, 1–180.

FAO (2022). "Land use statistics and indicators," in *Global, Regional and Country Trends – 2000–2020*. Rome. doi:10.4060/cc0963en

FAOStat (2026). *FAOSTAT Data Releases*. Rome: Food and Agriculture Organization of the United Nations.

Höglund-Isaksson, L., Gómez-Sanabria, A., Klimont, Z., Rafaj, P., and Schöpp, W. (2020). Technical potentials and costs for reducing global anthropogenic methane emissions in the 2050 timeframe—results from the GAINS model. *Environ. Res. Commun.* 2 (2), 025004. doi:10.1088/2515-7620/ab7457

Hayek, M. N., and Miller, S. M. (2021). Underestimates of methane from intensively raised animals could undermine goals of sustainable development. *Environ. Res. Lett.* 16, 063006. doi:10.1088/1748-9326/ac02ef

IPCC (2006). IPCC guidelines for national greenhouse gas inventories. *Chapter 10 Emiss. Livest. Manure Manag.* 12–87. Available online at: https://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/4_Volume4/V4_10_Ch10_Livestock.pdf (Accessed January 4, 2026).

IPCC (2019). *Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories*. Available online at: https://www.ipcc.ch/site/assets/uploads/2019/12/19R_V0_01_Overview.pdf (Accessed January 4, 2026).

Kristensen, J. Å., Barbero-Palacios, L., Barrio, I. C., Jacobsen, I. B. D., Kerby, J. T., López-Blanco, E., et al. (2024). Tree planting is no climate solution at northern high latitudes. *Nat. Geosci.* 17, 1087–1092. doi:10.1038/s41561-024-01573-4

Mukherji, A., Marchall, S., Arango, J., Costa Jr, C., Flintan, F., Hebebrand, C., et al. (2024). *Breakthrough agenda report: agriculture*. Montpellier: Cgiar. Available online at: https://hdl.handle.net/10568/152247 (Accessed January 4, 2026).

Niamir-Fuller, M. (2026). Welcome to the international year of rangelands and pastoralists – 2026. Available online at: https://iyrp.info/sites/default/files/2026-03/Felix-Dodds-Guest-blog-by-Maryam-Niamir.docx (Accessed January 4, 2026).

Scoones, I. (2023). Livestock, methane, and climate change: the politics of global assessments. *Wiley Interdiscip. Rev. Clim. Change* 14 (1), e790. doi:10.1002/wcc.790

Shi, F., Ma, Z., Mi, J., Yang, X., Jing, X., Yang, X., et al. (2025). Methane emissions from indigenous nitrogen-efficient bovidae are overestimated. *Commun. Earth and Environ.* 6, 786. doi:10.1038/s43247-025-02755-7

Steinfeld, H., Gerber, P., and Wassenaar, T. (2006). *Livestock's Long Shadow: Environmental Issues and Options*. Rome: FAO.